MARKED UP VERSION OF SUBSTITUTE SPECIFICATION
PURSUANT TO 37 C.F.R.§ 1.121(b)(3)(iii)

VAW-5

DEVICE FOR FILTERING AND ADDING GRAIN REFINING AGENT TO METAL MELTS

BACKGROUND OF THE INVENTION

[0001] The invention relates to a device for filtering and adding grain refining materials to metal melts with a first filter and a feed for a grain-refining material, where the first filter has a porous filter medium.

[0002] It is known from the prior art that metal melts, e.g., melts of aluminum alloys, can be filtered during the casting process. As an example of this, reference is subsequently made to the casting of aluminum alloys. However, the filtering of metal melts is also known, for example, for copper and steel alloys. During the casting of aluminum, the metal melt flows out of the casting furnace via an inline degasser and a device for filtering and adding grain-refining materials to the casting mo[u]ld. The inline degasser removes in an inherently known fashion essentially dissolved gaseous impurities from the aluminum [molt] melt. The dissolved gaseous impurities [This] predominantly [involves]

include dissolved hydrogen. After dissolved impurities have been removed or reduced, a grain-refining material, for example, an aluminum-titanium-boron master alloy[s], is supplied to the aluminum melt according to the prior art. According to the prior art, [After] after this grain-refining material has been supplied, resulting in smaller grain sizes in the solidified material during the subsequent casting, [according to the prior art] the aluminum melt is filtered to remove undissolved impurities, i.e., solid particles not dissolved in the melt. These undissolved impurities [comprise] include, for example, aluminum oxide particles, aluminum carbides, aluminum carbonitrides, etc. These undissolved impurities have sizes of around 1 to 100 um. Following the filtration process, the aluminum melt then flows to the casting mo[u]ld, as mentioned previously, and is there cast into ingots, for example.

[0003] According to the prior art, the melt is filtered after adding the grain-refining materials since the grain-refining materials also carry undissolved impurities into the melt. For example, the aluminum-titanium-boron master alloy used as a grain-refining material contains large insoluble titanium diboride particles and oxide inclusions which are undesirable in the subsequent cast product.

[0004] Various types of filters are known for filtering aluminum melts. Especially reasonably priced and space-saving filtration can be achieved by using so-called ceramic foam filters. These ceramic foam filters are used in plate form[,] and are approximately 50 mm thick[,]. In ceramic foam filters, [and the] aluminum melt[s] flows through a filter in a direction perpendicular to the plane of the plate. These ceramic

foam filters are manufactured by impregnating an open-pore polyurethane foam with a water-based aluminum oxide sludge and binders. This impregnated polyurethane foam is then dried and baked whereby the polyurethane foam is burnt away and a negative image of the foam structure is left as ceramic foam. The filter efficiency of ceramic foam filters when used according to the prior art is moderate to good.

[0005] Another known filter system for filtering aluminum melts are the so-called loose-fill bed filters. In a loose-fill bed filter, the filter medium through which the aluminum melt is passed consists of aluminum oxide granules or beads that form [as] a partly layered fill in a filter box. If loose-fill bed filters exclusively are used [exclusively] for filtering, [this requires] large filter boxes [which however] are required. Large filter boxes, however, have [a] significantly longer service [life compared with using] lives than those of ceramic foam filters. The filter efficiency of loose-fill bed filters can be described as consistently good.

[0006] The simple filter systems known from the prior art[,] (such as, for example, ceramic foam filters) are distinguished by lower costs and a lower space requirement compared with more expensive filter systems, such as loose-fill bed filters, for example. At the same time, the expensive systems known from the prior art exhibit [a] higher filter [efficiency] efficiencies and longer service lives.

SUMMARY OF THE INVENTION

[0007] On the basis of the prior art described previously, the [problem for] object of the present

invention is to propose a device for filtering and adding grain-refining materials to metal melts which makes it possible to achieve a high filter efficiency with simple filter systems.

BRIEF DESCRIPTION OF THE DRAWING

[0008] FIG. 1 shows a sectional view of a device for filtering and adding grain-refining materials to metal melts in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0009] According to the invention, the [problem] object derived and [indicated] discussed previously is [solved] achieved by providing the feed for the grain-refining material in the direction of flow after the first filter and providing a second filter in the direction of flow after the feed for the grain-refining material. Surprisingly, it has been found that for metal melts the filter properties of a filter having a porous filter medium are so significantly influenced by the previous addition of grain-refining materials towards lower filter efficiencies that the better filter efficiency of the first filter can even justify adding grain-refining material with the undissolved impurities contained therein after the first filter. In order to remove the undissolved impurities carried into the melt via the grain-refining material, a second filter is provided in the direction of flow after the feed for the grain-refining material.

[0010] Tests have shown that, with respect to their filter efficiency, especially filters based on filtration by means of cake formation react sensitively to the

addition of grain-refining material. If these filters are used after the addition of grain-refining material, cake formation is impeded or even prevented whereby these filters do not attain their full filter action. The filter efficiency of [this] such a filter is significantly improved by the arrangement of the first filter based on cake filtration before the feed for the grain-refining material according to the invention.

[0011] In a ceramic foam filter, [without] when grain-refining material [being] is not added before the filter, bridges [are formed] consisting of an accumulation of undissolved impurities are formed. These bridges bring about a significant improvement in the filter efficiency of the ceramic foam filter. This bridge formation cannot be observed when grain-refining material is added before the ceramic foam filter. Accordingly, the first filter of the device according to the invention preferably has a plate made of ceramic foam.

[0012] It has been found that the bridges of undissolved impurities which improve the filter efficiency do not form over the entire 50 mm thickness of the ceramic foam plates normally used. With regard to the flow resistance in a device according to the invention, the ceramic foam plate therefore has a thickness of 5 to 30 mm, preferably 10 to 15 mm.

[0013] Alternatively or [cumulatively] in addition to a ceramic foam plate, the first filter advantageously has at least one element of sintered material and/or an element consisting of material deposited by CVD (Chemical Vapo[u]r Deposition).

[0014] Porous media are preferably suitable for filtering solid undissolved impurities. Accordingly, the device according to the invention is thereby preferably

arranged so that the second filter has a porous filter medium.

[0015] As a result of the relatively low load of undissolved impurities, a deep-bed filter is especially suitable for filtering the undissolved impurities introduced into the metal melt by the grain-refining material after the first filter. In view of the low impurity load, this deep bed filter can have considerably smaller dimensions than those normally required when deep-bed filters alone are used for filtration.

[0016] A particularly suitable deep-bed filter for filtering metal melts is the so-called loose-fill bed filter. In a loose-fill bed filter, the porous material is formed [by] from a filling of generally compact filter beads and/or filter granulars.

[0017] According to another refinement, the first filter and/or the second filter of the device according to the invention can be heated. [The] This allows for multiple usage of the first and/or second filters for successive batches.

[0018] In addition to the device, the invention also relates to a method for filtering and adding grain-refining materials to metal melts where the melt is filtered with the aid of a first filter having a porous filter medium and a grain-refining material is supplied to the melt. A method of this type known from the prior art is improved, on the basis of the [problem] object according to the invention indicated above, by supplying the grain-refining material to the melt after the first filter and filtering the melt in the direction of flow after the feed for the grain-refining material with the aid of a second filter.

[0019] The invention may include a device for filtering and adding grain-refining materials to metal melts with a first filter and a feed for a grain-refining material, whereby the first filter has a porous filter medium, characterized in that the feed for the grain-refining material is arranged in the direction of flow after the first filter and a second filter is arranged in the direction of flow after the feed for the grain-refining material.

[0020] There are now a plurality of possibilities for configuring and further developing the device according to the invention or the method according to the invention for filtering and adding grain-refining material to metal melts. For this purpose, reference is made to the following: [on the one hand, for example, to the claims assigned to Claim 1] The invention may include one or more of the following features: (1) that the first filter is configured to operate based on cake filtration; (2) that the first filter has a ceramic foam plate; (3) that the ceramic foam plate has a thickness of 5 to 30 mm, preferably 10 to 15 mm; (4) that the first filter includes a sintered material; (5) that the first material includes a material deposited by CVD; (6) that the second material has a porous filter medium; (7) that the second filter includes a deep-bed filter; (8) that the deep-bed filter is constructed as a loose-fill bed filter; and (9) that the first filter and/or the second filter can be heated. [and on the other hand,]

[0021] Reference is also made to the description of an example of an embodiment in connection with the [drawings] FIG.

[0022] [The only figure in the drawings] FIG. 1 shows a schematic cross-section of an example of an embodiment

of a device according to the invention for filtering and adding grain-refining materials to metal melts.

[0023] The example [of embodiment of a device according to the invention] shown in [the only figure] FIG. 1 has a lower outer frame 1 and an upper outer frame 2. In the lower outer frame 1 are the regions through which an aluminum melt flows in the present example [of embodiment], as defined by a thermally resistant outer lining 3 which interacts with a thermally resistant upper lining 4 of the upper outer frame 2.

[0024] In the example [of embodiment] shown in [the only figure] FIG. 1, the aluminum melt is shown by [the] horizontal shading. The lower lining 3 and the upper lining 4 define in their interaction a first filter chamber 5, an addition chamber 6 for the grain-refining material, [and] a second filter chamber 7, [as well as] an inlet region 8, and an outlet region 9.

[0025] In the first filter chamber 5, a ceramic foam plate 11 is provided as the first filter. The plate 11 is arranged at a small angle to the horizontal to allow the removal of gas inclusions.

[0026] In the addition chamber 6, a wire 12, consisting of a grain-refining material, is supplied by a feed (not shown in detail) through a feed opening 13 at a defined speed. The wire 12 melts in the aluminum melt whereby the grain-refining materials go[es] into solution [in] at a defined concentration.

[0027] The first filter chamber 5 and the addition chamber 6 are provided with a common first drain 14 which makes it possible to empty the first filter chamber 5 and the addition chamber 6 after filtering a charge. Usually, according to the prior art, the ceramic foam plate 11 is exchanged after filtering each batch. This

is not absolutely necessary when a ceramic foam filter is used in a device according to the invention. Consequently, the first filter chamber 5 can be heated jointly with the addition chamber 6 so that the same ceramic foam plate 11 can be good for several batches. In this case, the first filter chamber 5 and the addition chamber 6 are not emptied after filtering a batch. In the second filter chamber 7, [there is provided on a grid 15] a loose-fill bed filter 16, consisting of a plurality of aluminum oxide beads, is provided on a grid 15. The second filter chamber 7 can be heated via heating element 17 whereby emptying of the second filter chamber 7 between two batches is dispensed with. In order to make it possible to change the loose-fill bed filter 16, the second filter chamber 7 also has a second drain 18. As an alternative to the heating element 17 shown in [the only figure] FIG. 1, [this] heating can also be implemented, for example, by immersing [as] a [rod] heating rod, [immersed] preferably arranged below the loose-fill bed filter, in the melt[, which is preferably arranged below the loose-fill bed filter].

[0028] During operation of the device according to the invention for filtering and adding grain-refining media to metal melts, especially aluminum melts, as shown in [the only figure] FIG. 1, a first filtration of the aluminum melt takes place in the first filter chamber 5 with an efficiency between 80 and 95% which is essentially ensured by the bridge formation in the pores of the ceramic foam filter described above. This bridge formation is impeded in the prior art by the grain-refining material being supplied to the aluminum melt before the first filter. It has been found that in this case no bridge formation takes place inside the pores of

the ceramic foam filter. After the first filtration, the aluminum melt enters the addition chamber 6 in which a defined amount of grain-refining material is brought into solution. The undesirable undissolved impurities contained in the grain-refining material are then largely removed [in] using a relatively small loose-fill bed filter 16 in [a] second filter chamber 7. As a result, in the outlet region there is an aluminum melt, with a very small fraction of undissolved impurities, which is then cast into high-quality casting products, such as ingots, for example.

MARKED UP VERSION OF REPLACEMENT ABSTRACT
PURSUANT TO 37 C.F.R.§ 1.121(b)(2)(iii)

VAW-5

ABSTRACT

[0029] The invention relates to a device for filtering and adding grain refining materials to metal melts with a first filter [(10)] and a feed for a grain-refining material, where the first filter has a porous filter medium. The filter efficiency of the first filter [(10)] is substantially improved according to the invention by arranging the feed for the grain-refining material in the direction of flow after the first filter [(10)]. The undissolved impurities introduced via the grain-refining material are removed by positioning a second filter [(16)] in the direction of flow after the feed for the grain refining material.

[The single figure is provided for publication with the summary.]